

INTEGRATED ACCESS DEVICE-RESIDENT, ROBBED IN-BAND TIME  
SLOT MECHANISM FOR EFFECTING CONTEMPORANEOUS MANAGEMENT  
OF REMOTE DIGITAL COMMUNICATION UNITS

FIELD OF THE INVENTION

5           The present invention relates in general to  
communication systems and components therefor, and is  
particularly directed to a new and improved remote  
communication device management mechanism, that is  
executable by the supervisory communication control  
10 processor of a digital subscriber line (DSL)  
communication unit, such as an integrated access device  
(IAD), and through which a user may effectively  
simultaneously or contemporaneously manage (controllably  
configure, read the status of, etc.) a number of remote  
15 customer premises equipments (CPEs), via robbed in-band  
channels of respective time division multiplexed (TDM)  
digital communication links of a telecommunication  
service provider, through which access to a public  
switched telephone network (PSTN) serving remote  
20 customers is provided.

BACKGROUND OF THE INVENTION

Many users of digital communication networks, such  
as but not limited to financial, educational, medical,  
industrial and governmental institutions, whose  
25 operations rely upon vast amounts of archival storage and  
large main frame data processing systems, have

traditionally employed legacy telecommunication systems and protocols to transport data from one point to another. A reduced complexity diagram of such a digital communication network is diagrammatically illustrated in Figure 1, wherein a host/master data terminal 10 communicates over a plurality of dedicated data links (e.g., T1 links) 12 to a PSTN 14 serving various voice/data terminal equipments installed at a plurality of remote sites 16.

10 With ongoing improvements in digital communication technology, telecommunication service providers currently prefer to offer their customers digital subscriber line (DSL) communication technology, that takes advantage of higher communication speeds and information processing capacities. Although DSL schemes enable the transport of any type of user data between remote sites, successful installation and operation of a respective piece of communication equipment requires that it be continuously managed or supervised.

20 This is customarily accomplished by robbing one of the DS0 channels of the T1 link and using the robbed channel to conduct a supervisory management/control session with a respectively addressed piece of communication equipment. To accommodate the possibility of an interruption in service over its associated T1 link, each site employs an auxiliary (reduced bandwidth and speed) Basic Rate Interface (BRI) link 18, (dial-back) access to which is afforded via an Integrated

services digital network (ISDN) Service Unit (ISU) 19, which is coupled to the T1 Service Unit (TSU) 20 for the T1 link of interest. At the host/master data terminal 10, the various T1 links 12 are also terminated at respective  
5 local TSU/ISU pairs 22/23. The local TSU/ISU pairs 22/23 are daisy-chained to the host site's supervisory communication processor 24 via a serial control link 26.

In order to initiate a management session with a given piece of equipment, the user/operator of the data  
10 terminal 10 issues a message containing (the address of) that piece of equipment, for example, from a management station 11. This message is forwarded from the data terminal's supervisory processor 13 over a robbed in-band DS0 channel over the local supervisory control link 26,  
15 and is read by each local TSU/ISU pair 22/23. If the message is not intended for a receiving device, it is forwarded to the next daisy chained device. In addition, it is forwarded over the associated T1 links 12 to the various remote sites' ISU/TSUs 19/20. Only the device for  
20 whom the message is intended will respond. The others simply pass the message on.

Once the addressed device has responded and a management session communication link has been established between the host and the device, the robbed  
25 DS0 channel is dedicated to only the ongoing management session between them, and remains so dedicated, until the management session between management station 11 and the addressed (ISU, TSU) device is terminated. Unfortunately,

this one-to-one management session approach severely limits the use of available resources, as its mandates the need for redundant sets of TSUs and ISUs terminating the T1 links at the master terminal, as well as limiting  
5 the availability of the robbed in-band DS0 channel for only one management session at a time.

#### SUMMARY OF THE INVENTION

In accordance with the present invention, advantage is taken of the communication signal processing  
10 capability and capacity of a multi-digital circuit servicing host IAD equipment, to provide contemporaneous management of multiple remote digital communication devices (TSU/ISUs) by way of a respective robbed in-band (T1) channel per remote site, and without having to  
15 terminate each high speed digital (T1) link with an associated TSU/ISU pair at the master site. As a non-limiting example, the IAD may comprise an Atlas 800<sup>PLUS</sup> IAD, manufactured by Adtran Corp., Huntsville, Alabama. It should be observed, however, that the invention is not  
20 limited to use with this or any other particular type of integrated access device, but is intended as an augmentation to the communication supervisory control mechanisms employed in IADs supplied from a variety of communication equipment manufacturers. Since the IAD  
25 itself terminates each digital (T1/T3) link, redundant TSU/ISU pairs that would otherwise be used at the central

office can now be used to expand telecom service to additional customer sites.

The multi-digital circuit servicing IAD in which the present is installed is coupled to one or more user SNMP  
5 workstations. It is further coupled over a T1/T3 digital communication link to the PSTN. The network structure between the PSTN and the remote sites remains unchanged from that of Figure 1, with the PSTN being coupled over respective T1 links and dial-back BRI links to voice/data  
10 terminal devices (ISUs/TSUs) at the remote sites. Using a distributed device-based data link protocol for the DS0 channel structure, the IAD establishes a management session and forwards user commands over a respectively robbed in-band channel to an addressed remote device.

15 In response to these user commands, the identified remote device returns response messages back to the IAD, which forwards then on to the local user SNMP terminal. Unlike the system of Figure 1, which dedicates the robbed in-band DS0 channel for only one device management  
20 session at a time, the invention distributes respective robbed in-band DS0 channels among all of the remote devices, making it is effectively simultaneously available for additional sessions with other remote units, depending upon user invoked activity with  
25 respectively identified remote devices from the SNMP workstation(s).

To initiate a session with a remote device, a user logs onto the IAD, as by invoking a telecommunication

network (TELNET) session or by means of a chain-in port. Via a device (client) menu, the (SNMP) user enters the address (device ID) of the remote device with which the management session is to be conducted. The IAD employs a  
5    respective robbed in-band DS0 channel to establish a connection with the identified remote device. During a management session, the SNMP IAD may become an SNMP request proxy and/or an SNMP trap proxy for the remote device, using dedicated menu selection identifiers for  
10   the purpose in accordance with standard user interface menu selections. All SNMP requests from the user workstation are forwarded to the IP address associated with the IAD. To denote that a message is intended for a remote unit, the address or ID is appended to the  
15   community identifier of the IAD, so that the request will be forwarded to the identified remote device.

Once a connection is established, a remote device's user interface is displayed at the SNMP workstation. The display of a remote device user interface provides the  
20   SNMP workstation user with the ability to configure the remote device, as if directly connected to the remote device. Events from the workstation and response messages from one or more remote devices inserted into the respective robbed in-band DS0 channels are then  
25   processed. Thus, the IAD becomes a transparent interface between an SNMP workstation and a remote device, using its robbed in-band message routing functionality to multiplex one or more management messages to one or more

remote devices. When a session has been completed, the user terminates the connection. However, as it continuously monitors the robbed DS0 channels, for its ID in all traffic being carried by the management channel, 5 the remote device management mechanism is effectively continuously 'up' for user-to-remote device sessions.

There is no modification of the control software employed by a respective remote device to communicate with the IAD over a robbed channel. As far as the remote 10 device is concerned, it is interfaced with a robbed DS0 channel in the same manner as in the system of Figure 1. When not participating in a management communication session over a robbed DS0 channel, a respective remote device (ISU, TSU) is in an idle or 'wait for message' 15 state. In association with the IAD transmitting a management session message, the remote device reads the contents of the robbed DS0 channel for the presence of its identification in any management message. When the ID in the message matches its unique ID, the remote device 20 processes the received message. In addition to acting on commands contained in management messages, processing of a message includes returning the message back to the IAD which forwards the returned message back to the user SNMP workstation to indicate completion of requested action.

## 25 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a reduced complexity diagram of a conventional digital communication network linking TSU

and ISU devices at each of a plurality of remote sites with redundant pairs of TSU and ISU devices at a host/master data terminal;

Figure 2 shows a modification of the digital communication network diagram of Figure 1, in which TSU/ISU pairs at the host site have been replaced by a multi-digital circuit servicing IAD platform;

Figure 3 shows the structure of a robbed DS0 channel used in the system of Figure 2; and

Figures 4 and 5 show respective steps of the remote digital communication service unit management mechanism of the present invention.

#### DETAILED DESCRIPTION

Before describing the improved remote digital communication service unit management mechanism according to the present invention, it should be observed that the invention resides primarily in a prescribed software routine, which is executable by the supervisory communications controller of a multi-digital circuit servicing IAD platform, such as above-referenced Atlas 800<sup>PLUS</sup> IAD, that is configured to control the operation of a plurality of digital telecommunication signalling units, such as multiple TSUs and ISUs, of a digital telecommunication system. Consequently, the configuration of such a system has illustrated in the drawings by readily understandable block diagrams, showing only those specific details that are pertinent to the present

invention, so as not to obscure the disclosure with details which will be readily apparent to those skilled in the art having the benefit of the description herein. The remote digital communication service unit management  
5 mechanism itself has been illustrated in flow chart format, which is primarily intended to show the various steps of the invention in a convenient functional sequence, whereby the present invention may be more readily understood.

10 Figure 2 shows a modification of the reduced complexity digital communication network diagram of Figure 1, in which the TSU/ISU pairs and associated communication controller at the host/master site 10 have been replaced with a multi-digital circuit servicing IAD  
15 platform 30, such as above-referenced Atlas 800<sup>PLUS</sup> IAD, as a non-limiting example. Because such an IAD has card slots for a plurality of (e.g., 34) T1 links or multiple channels of a T3 link, associated transceivers that interface directly with respective digital links to the  
20 PSTN, the need for individually installed local ISU and TSU pairs terminating associated T1 links with the PSTN is eliminated.

In the diagram of Figure 2, the IAD 30 is coupled over a network (e.g., Ethernet) 32 to a simplified  
25 network management protocol (SNMP) workstation 34. It is further coupled to the PSTN 14 by way of a T1/T3 digital communication link 40, that includes a primary rate interface (PRI) segment 42 and a T3 segment 44. The

network structure between the PSTN and the remote sites remains unchanged from that of Figure 1, with the PSTN 14 being coupled over respective T1 links 12 and dial-back BRI links 18 to various voice/data terminal equipments 5 ISUs 19 and TSUs 20 installed at remote sites 16, as discussed previously.

As described briefly above, using the data link protocol of the DS0 channel structure of Figure 3 (to be described) for data transfers across the robbed in-band 10 (8 Kbps) DS0 channel of a respective T1 channel 12, the remote digital communication service unit management mechanism of the invention establishes a management session and then forwards user commands to a respectively addressed remote device. In response to these user 15 commands, the identified remote device returns response messages back to the IAD, which forwards then on to the local user SNMP terminal 34. However, unlike dedicating the robbed in-band DS0 channel to conduct only one device management session at a time, as in the architecture of 20 Figure 1, once a management session has been established in the system of Figure 2, because the robbed channels are distributed (multiplexed) among all of the remote devices, they are available for additional sessions with other units at the same time, depending upon user invoked 25 activity with respectively identified remote devices from the SNMP workstation.

For this purpose, the IAD 30 and the remote devices execute the software routine shown in the flow charts of

Figures 4 and 5. To initiate a session with a remote device, in step 401, the user logs in to the IAD, as by invoking a telecommunication network (TELNET) session or by means of a chain-in port. Via a device (client) menu, 5 in step 402, the user enters the address (device ID) of the remote device with which the management session is to be conducted. For security purposes, this may also include the entry of a unique password associated with the identified remote device.

10 In response to the user initiating a remote connection request, in step 403, the IAD uses an available (robbed) in-band DS0 channel to establish a connection with the identified remote device. The structure that may be employed for the robbed in-band DS0 15 channel (e.g., DS0-1) is shown in Figure 3 as including a data link protocol header 301, an application protocol header 302, a data field 303, an application protocol end sequence 304 and a data link protocol end sequence 305. It should be noted that the invention is not limited to 20 use with only DS0 channel one (DS0-1) or the structure shown in Figure 3, which are merely provided as a non-limiting example.

Once a connection has been established with the identified remote device, the routine transitions to step 25 404 and displays the remote device's user interface. The display of a remote device user interface provides the SNMP workstation user with the ability to configure the remote device, as if directly connected to the remote

device. With a connection established in step 403 to the identified remote device over the robbed in-band DS0 channel, events from the workstation and response messages from one or more remote devices that have been  
5 inserted into the robbed in-band DS0 channel are processed in step 405.

During a management session, the SNMP IAD may become an SNMP request proxy and/or an SNMP trap proxy for the remote device, using dedicated menu selection identifiers  
10 for the purpose in accordance with standard user interface menu selections. All SNMP requests from the user workstation are forwarded to the IP address associated with the IAD. To denote that a message is intended for a respective remote unit, the address or ID  
15 is appended to the community identifier of the IAD, so that the request will be forwarded to the identified remote device.

In other words, the IAD becomes a transparent interface between the SNMP workstation and the remote  
20 device, using its robbed in-band message routing functionality to multiplex one or more management messages to one or more remote devices. Once a session with a respective device has been completed, the user terminates the connection in step 406. However, since  
25 each remote device continuously monitors the robbed DS0 byte for its ID in all traffic being carried by the management channel, the remote device management

mechanism is effectively continuously 'open' or 'up' for user-to-remote device sessions.

Associated with the IAD flow chart of Figure 4 is the device flow chart of Figure 5. It should be noted  
5 that the various steps of the flow chart of Figure 5 do not represent a modification of the control software employed by the remote device to communicate with the IAD over a robbed channel, as the invention does not require modification of a remote device. Rather the steps of  
10 Figure 5 simply show how a remote device responds to the IAD communication control routine of Figure 4. As far as the remote device is concerned, it is interfaced with a robbed DS0 channel in the same manner as in the system of Figure 1.

15 As shown at step 501 of Figure 5, when not participating in a management communication session over the robbed DS0 channel (here with the IAD), the remote device (ISU, TSU) is in an idle or 'wait for message' state. In association with the IAD transmitting a  
20 management session message to a remote device in step 403, described above, in step 502, the remote device monitors (reads) the contents of the robbed DS0 channel for the presence of its identification in any management message. Next, in query step 503, a determination is made  
25 as to whether the ID contained in the message matches the unique ID of that remote device. If the answer to the query step 503 is NO, the message is discarded in step 504 and the routine returns to step 501. On the other

hand, if the answer to the query step 503 is YES (indicating that the message is intended for that remote device), the routine transitions to step 505 and processes the received message. As pointed out earlier, 5 in addition to acting on commands contained in management messages, processing of a message in step 505 includes returning the message back to the IAD 30, which forwards the returned message back to the user terminal (SNMP workstation 34) to indicate completion of the requested 10 action.

As will be appreciated from the foregoing description, the hardware intensity and resource usage inefficiency drawbacks of the conventional remote device management approach, which dedicates a robbed DS0 channel 15 to only a single management session between a host management site and a remote device at a time, are effectively obviated by taking advantage of the signal processing capability and capacity of a multi-digital circuit servicing host IAD equipment, and installing 20 therein a mechanism that provides for effective simultaneous management of multiple remote digital communication devices (TSU/ISUs) by one or more SNMP workstations. Although only one respective robbed in-band (T1) channel is used per remote site, it is unnecessary 25 to terminate each high speed digital (T1) link with an associated TSU/ISU pair at the master site.

While we have shown and described an embodiment in accordance with the present invention, it is to be

understood that the same is not limited thereto but is  
susceptible to numerous changes and modifications as  
known to a person skilled in the art. We therefore do not  
wish to be limited to the details shown and described  
5 herein, but intend to cover all such changes and  
modifications as are obvious to one of ordinary skill in  
the art.